2.2.3 Geology/Soils/Seismic/Topography

2.2.3.1 Regulatory Setting

For geologic and topographic features, the key federal law is the Historic Sites Act of 1935, which establishes a national registry of natural landmarks and protects "outstanding examples of major geological features." Topographic and geologic features are also protected under CEQA.

This section also discusses geology, soils, and seismic concerns as they relate to public safety and project design. Earthquakes are prime considerations in the design and retrofit of structures. Caltrans' Office of Earthquake Engineering is responsible for assessing the seismic hazard for Caltrans projects. Structures are designed using Caltrans' Seismic Design Criteria (SDC). The SDC provides the minimum seismic requirements for highway bridges designed in California. A bridge's category and classification will determine its seismic performance level and which methods are used for estimating the seismic demands and structural capabilities. For more information, please see Caltrans' Division of Engineering Services, Office of Earthquake Engineering, SDC.

2.2.3.2 Affected Environment

This section has been prepared based on the analysis and findings presented in the *District Preliminary Geotechnical Report* (December 2015).

Topography

The project area is located within an embayment on the southeastern part of the Los Angeles Basin called the Tustin Plain, between Loma Ridge on the northeast and the San Joaquin Hills on the southwest. Loma Ridge rises to elevation higher than 1,000 feet and the San Joaquin Hills rise to approximately 1,000 feet. The southern Tustin Plain slopes westerly from approximate elevations of 200 to 300 feet along Loma Ridge to approximately +50 feet near the north end of the San Joaquin Hills. The basin floor rises to as much as 100 feet across the Newport Inglewood Structural Zone (NISZ). The existing ground surface is up to approximately El. +260 feet at the southeast end of the corridor and +30 feet along the northwestern side of the corridor. The overall relief within the project vicinity consists of an increase in elevation trending southeast along the corridor. Figure 2.2.3-1 for a topographic map of the project area.

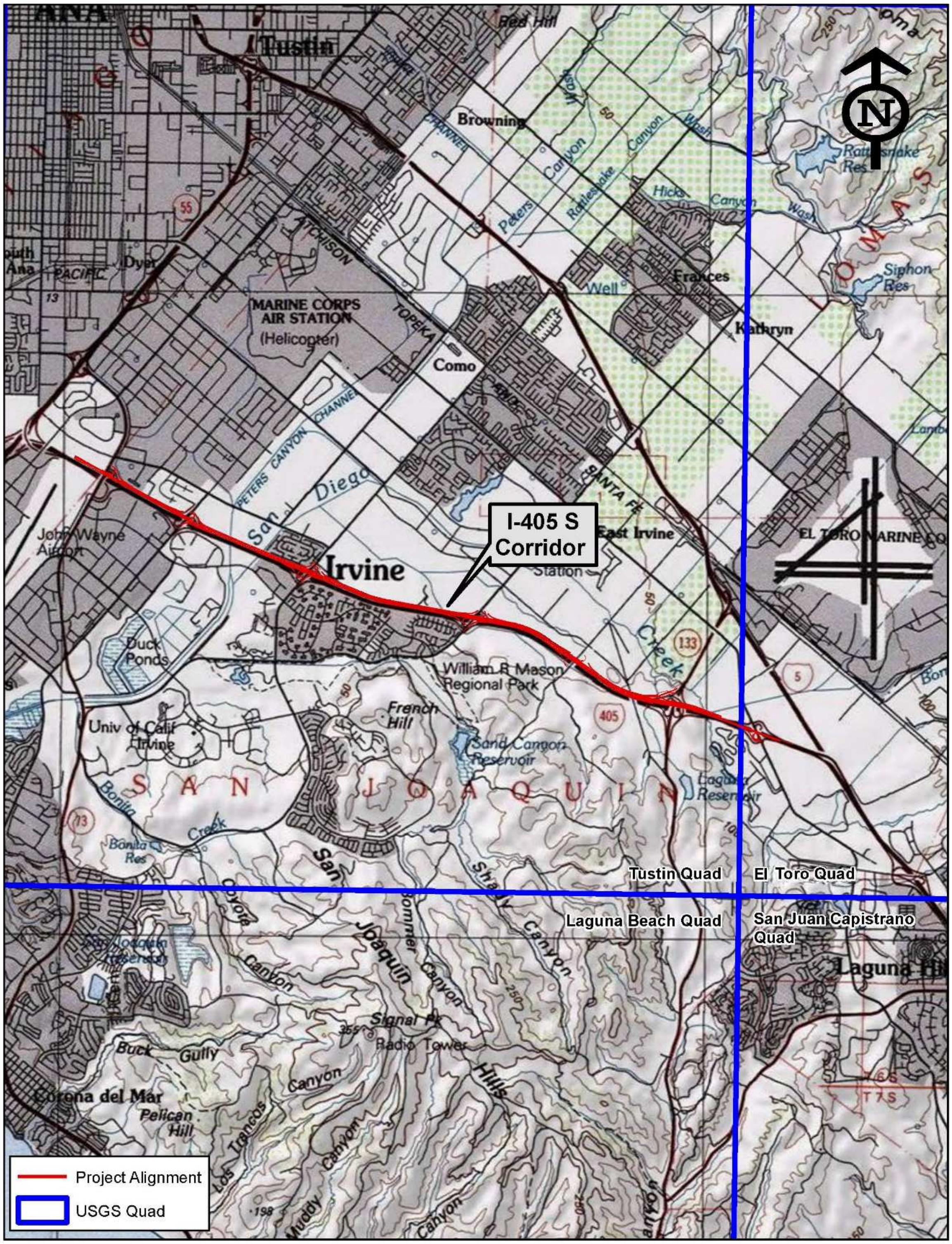

Figure 2.2.3-1. Topographic Map of the Project Area

Geologic Landforms/Soils

The project area is situated along the southeastern margin of the Tustin Plain, immediately north of the San Joaquin Hills. The Tustin Plain is a comparatively featureless lowland or floodplain, the eastern end of which is bounded to the northeast by Loma Ridge and to the south by the San Joaquin Hills, all of which are part of the Santa Ana Mountains Block (Woodford *et al.,* 1954; Morton and Miller, 2006). The Santa Ana Mountains Block, in turn, is (1) the southeastern part of the Los Angeles Basin, which was a large, fault-bounded, deep-water marine trough during the Miocene and Pliocene Epochs, and (2) part of the Northern Peninsular Ranges Province, in which major linear geologic structures (i.e., faults, folds) and the resulting geographic features (i.e., mountains, valleys) trend in a dominantly northwesterly direction (Jahns, 1954; Woodford *et al.,* 1954;Morton and Miller, 2006). Regional surficial geologic mapping by Morton (2004) and Morton and Miller (2006) indicates that (1) the floor of the Tustin Plain is immediately underlain mostly by comparatively flat lying and undissected, unconsolidated to poorly consolidated, alluvial fan deposits and some channel deposits of late Pleistocene to Holocene age, (2) similarly flat lying but more dissected, poorly to moderately consolidated, marine and nonmarine terrace deposits of early to late Pleistocene age occur around the margins of the Tustin Plain and the adjacent lower slopes of the San Joaquin Hills and Loma Ridge, and (3) folded, highly eroded, poorly to highly consolidated, marine and nonmarine units of Paleocene to Pliocene age that are exposed in the latter two areas and occur at great depth under the Pleistocene units of Tustin Plain. Regional surficial geologic mapping of the Tustin Plain and San Joaquin Hills is provided at scales of 1:250,000 by Rogers (1965), 1:100,000 by Morton (2004) and Morton and Miller (2006), and 1:48,000 by Morton and Miller (1981).

Groundwater

The proposed project area overlies the Orange Groundwater Management Zone. The Orange Groundwater Management Zone is located in the area designated by the California Department of Water Resources (DWR) as Basin 8-1, the "Coastal Plain of Orange County Groundwater Basin" in Bulletin 118 (California Department of Water Resources, 2004). The basin covers an area of approximately 350 square miles, bordered by Coyote Hills and Chino Hills to the north, the Santa Ana Mountains to the northeast, and the Pacific Ocean to the southwest. The Orange County Groundwater Basin, as defined by DWR Bulletin 118 Basin 8-1, has been subdivided into sub-basins.

The largest drainage in the site region is Peters Canyon Wash, which flows southerly from Loma Ridge to San Diego Creek and the Newport Bay. San Diego Creek is a minor creek that flows northwesterly from the east side of the Laguna Hills around the San Joaquin Hills to Newport Bay. The Peters Canyon Wash crosses the corridor towards the western portion of the corridor, while the San Diego Creek crosses the corridor several times as it wraps around the San Joaquin Hills.

Faulting and Seismicity

The geologic structure at the site is characterized by relatively flat-lying Quaternary strata overlying shallow to moderately dipping and faulted Tertiary-Cretaceous sedimentary and volcanic rocks). There are no mapped active faults crossing the site (Jennings and Bryant, 2010), and no Alquist-Priolo Earthquake fault zones have been identified in this area. The nearest major active or potentially active surface faults are the San Joaquin Hills blind thrust fault, Whittier Fault, and the Newport-Inglewood Structural Zone. The San Joaquin Hills blind thrust fault is located beneath the San Joaquin Hills as it is believed to have created the uplift within the hills as a fold and thrust belt. As a result, the blind thrust is located beneath the project site vicinity; although, because it is a blind thrust, no surface expression of fault rupture has been mapped. The nearest mapped Quaternary fault is the Newport-Inglewood Fault. The Newport-Inglewood Fault is located approximately 7.8 miles southwest of the project corridor. The NISZ is a northwesterly trending series of faults and folds located approximately 4.5 miles west of the western end of the corridor. The Whittier Fault, which extends northwesterly along the eastern flank of the Santa Ana Mountains, is located approximately 15.4 miles northeast of the site.

The project site is located in seismically active southern California. The present-day seismotectonic stress field in the Los Angeles region is one of north-northeasterly compression. This is indicated by the geologic structures, by earthquake focal-mechanism solutions, and by geodetic measurements. These data suggest compression rates of between 5 and 9 millimeters per year across the greater Los Angeles area.

Historical epicenter maps show widespread seismicity throughout the basin. Although historical earthquakes occur in proximity to known faults, they are difficult to directly associate with mapped faults. Part of this difficulty is because the basin is underlain by several subsurface thrust faults (blind faults). Earthquakes in the region occur primarily as loose clusters along the NISZ, along the southern margin of the Santa Monica Mountains, the southern margin of the Santa Susana and San Gabriel mountains, and in the Coyote Hills-Puente Hills area. There is no clustering or alignment of earthquakes in proximity to the site. There are fewer earthquakes in the Tustin Plain-western Santa Ana Mountains region than anywhere else in the Los Angeles Basin area. This apparent lack of earthquake activity suggests that the site area is tectonically stable and suggests that there are no unrecognized active faults at the site. Figure 2.2.3-2 for a map of fault lines located in proximity to the project.

I-405 PA-ED - I-5 to SR-55

Regional Fault Map

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Figure 2.2.3-2. Regional Fault Map

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Geologic Hazards

Geological hazards relevant to the project area include earthquake shaking and localized liquefaction. There are no known active surface faults within the project limits so the potential for ground rupture is considered low. The nearest active or potentially active fault is located approximately 3.4 miles from the project vicinity; as a result, moderate to intense ground shaking should be anticipated at the site in the event of an earthquake. Some near-surface alluvial sediments within the project area are susceptible to liquefaction due to moderate to intense ground shaking and historical groundwater levels ranging from 10 to 40 feet bgs.

2.2.3.3 Environmental Consequences

Alternative 1 (No Build)

Under the No Build Alternative, there would be no change to the existing corridor, posing no changes to the existing environment and requiring no disturbance of soils; therefore, there would be no impact to geologic resources.

Build Alternative 2 (Preferred Alternative) and Build Alternative 3

Selected areas along the project corridor are identified on the State Seismic Hazard Map of the Tustin Quadrangle (CGS, 2001) as being susceptible to liquefaction. These areas are located at: (1) San Diego Creek east of the SR-133/I-405 interchange, (2) University Drive, and (3) from east of Culver Drive to the western project limit. However, there is uncertainty in the published California Geological Survey (CGS) Seismic Hazard Maps because these maps were developed based on limited subsurface data and analysis. As part of the geotechnical study conducted for this project, detailed site-specific liquefaction analyses were performed at (1) San Diego Creek east of the SR-133/I-405 interchange, Culver Drive, and San Diego Creek Channel just east of Jamboree Road (EMI, 2015b, 2015c, 2015d). Site-specific liquefaction analysis was also performed at University Drive in a past PS&E project (EMI, 2003). Results of the above liquefaction analyses indicate the liquefaction potential is low at these locations, which contradict the findings of the CGS map. Thus, the project corridor has low liquefaction potential with only high potential limited to the area west of Jamboree Road, where no project improvements are located.

The project will have no effect on the Tustin Plain or other geological landforms in the project area, nor will the build alternatives affect any natural landmarks. In addition, the project area generally has a low to negligible potential for geologic hazards such as landslides, expansive soil, collapsible soil, tsunamis, seismic slope instability, and subsidence. Fault rupture potential is remote, and the risk of secondary seismic hazards is generally low. The primary seismic hazard at the site is strong shaking.

Seismicity

Although the proposed project site is located in seismically active southern California, it is within an existing transportation corridor. No structures would be constructed that would increase the current risk of loss, injury, or death as a result of ground shaking or seismically induced effects. The proposed project would not increase the risk of exposing people or structures to potential adverse effects because of seismic activities or seismic-related ground failure beyond the existing level already present.

Construction (Short-Term) Impacts

Liquefaction analyses indicate a low liquefaction potential at (1) San Diego Creek east of the SR-133/I-405 interchange, (2) University Drive, and (3) from east of Culver Drive to the western project limit. Construction activities would disturb soil outside and within the project footprint, primarily within the work and laydown areas, as well as construction traffic areas and the TCEs. During project construction of the build alternatives, excavated soil would be exposed and subject to increased potential for soil erosion. Conformance with the General Construction Permit and implementation of erosion and sediment control BMPs would minimize impacts into receiving waters.

2.2.3.4 Avoidance, Minimization, and/or Mitigation Measures

All project components will be designed in accordance with standard engineering practices and Caltrans standard specifications, Section 19 (Caltrans, 2015). No adverse effect would occur related to geology, soils, topography and seismicity, and no avoidance, minimization, and/or mitigation measures are required.